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Development and calibration of a new method geo-chronometric (U-Th-Sm)/He on magnetite and spinel in ultrabasic rocks

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(U-Th)/He thermo-geo-chronological dating method on accessory minerals, such as magnetites and spinels, provides new chronological constraints concerning: 1/ fluids circulation within the mantle and 2/ the thermal evolution of mantle derived rocks in ophiolite, subduction zones and oceanic core complex.

Nevertheless, this method is challenging due to the low concentrations of U, Th and Sm in these minerals (<10 ppb), the common loss of Th during sample digestion, and the high iron content in magnetites (that affects analytical conditions). In order to avoid these issues, we propose a method including HF-$HClO_4$ dissolution, and an Ion-Exchange-resin U, Th and Sm purification step. We also developed a routine for measuring U, Th and Sm in spinel and magnetite by LA-ICP-MS. In addition as this method requires external standards with crystallographic structure and U and Th concentrations similar to those in spinel and magnetites, we developed a new external standard of synthetic magnetite doped in U and Th at 40 ppb and 40 ppm and calibrated a natural spinel which has a U, Th and Sm concentration of 4 ppm, 90 ppm and 50 ppm respectively.

Our first quantitative results, obtained on Alpine magnetites (Schwartz et al., 2020) and on Egypt natural spinels, by LA-ICP-MS using traditional international glass standards are promising. The laser ablation technique overcomes the analytical difficulties related to the dissolution and purification of samples. It thus opens the way to the dating of magnetite as well as spinels in various ultramafic rocks such as mantle xenoliths or serpentinized peridotites in ophiolites.

Schwartz S., Gautheron C., Ketcham R.A., Brunet F., Corre M., Agranier A., Pinna-Jamme R., Haurine F., Monvoin G., Riel N., 2020, Unraveling the exhumation history of high-press ure ophiolites using magnetite (U-Th-Sm)/He thermochronometry. Earth and Planetary Science Letters 543 (2020) 116359.